



Origins of Life

Extremophiles

<http://library.thinkquest.org/C003763/index.php?page=origin07>

Imagine dwelling in a cave miles below the surface of the Earth with no oxygen to breathe, or surviving in puddles of sulphuric acid, or living in the superheated waters of submarine volcanic vents or the bitter cold of the Antarctic Dry Valleys. While the prospect of human survival in these environments is practically inconceivable, organisms called extremophiles have evolved to survive under these adverse conditions.

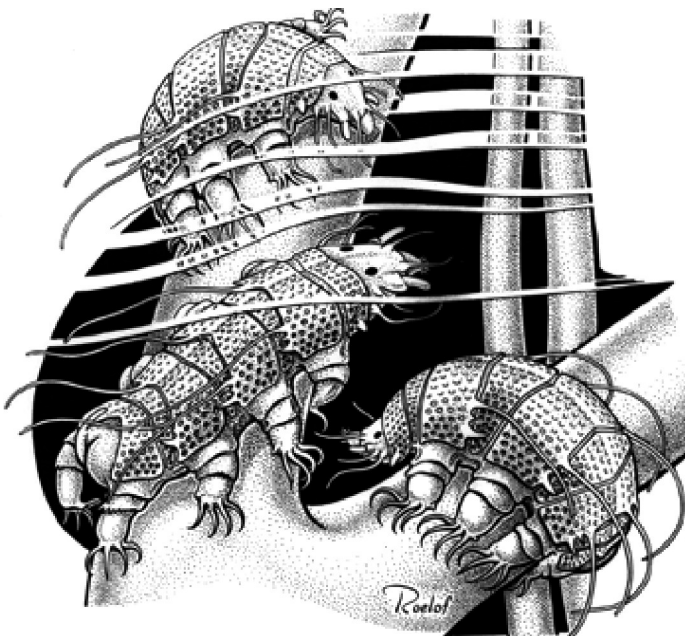
The fact that communities of microbes are happily thriving in extreme environments on Earth has served to expand the traditional notions of where life can exist on our planet and in the universe. Because of the nature of the chemistry which is the basis of human life, there are certain limitations to where we can survive. These limitations include the presence of oxygen, the boiling and freezing points of water

and low toleration of acidity and alkalinity extremes. However, just because humans can't survive beyond these constraints doesn't mean that other life forms are similarly limited by these boundaries.

One example of a particularly hardy life form that is able to withstand extreme temperatures are creatures called tardigrades (more affectionately referred to as 'water bears' because of their uncanny resemblance to a microscopic bear). Water bears are tiny multicellular organisms which are remarkably resilient when they are in a 'tun', a state of suspended animation in which the water bears become almost totally dehydrated. In 'tun' form, water bears are able to withstand high pressures, freezing and vacuum exposure.

At the other extreme (corny pun intended) are the organisms which have adapted to living in deep-sea volcanic vents, where temperatures exceed 700 degrees and where the water is a toxic mixture of metals. These vents on the bottom of the ocean are located on seams where tectonic plates are shifting. As the water in these vents heats up from the molten rock below, it dissolves a multitude of chemicals ranging from mercury to gold. When the heated water collides with the surrounding cold water, the chemicals precipitate, forming the black 'smoke' that is characteristic of these hydrothermal vents. Although these noxious waters seem inhospitable to life, they in fact support a variety of life forms who are nourished by the metallic 'smoke'.

Bathymodiolus mussels are an example of such a life form. These mussels are actually damaged by the poisonous environment they inhabit, yet they are able to continuously repair their own DNA, an ability that scientists predict could lend insight into techniques for extending



Tardigrades, also called 'water bears', are resilient organisms that are able to withstand high pressures, freezing and vacuum exposure. Courtesy: Global Diversity



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The giant tube worm lives around hydrothermal vents. Scientists once believed that no living thing could survive the combination of toxic chemicals, high temperatures, high pressures, and total darkness at these vents. Courtesy: J. Battista

human life spans. The vents are also home to bacteria who derive energy from the chemical reactions occurring there.

Life has evolved to fill every possible niche on Earth. Environments that were once shunned as being too extreme for life have, upon closer inspection, been revealed to support a menagerie of organisms. The search for life in harsh environments on Earth has opened up the eyes of scientists to the incredible range of conditions in which living things can exist. Life is tenacious and downright stubborn when it comes to survival. On Earth, wherever there is a source of energy and certain essential chemicals, there is likely to be life.

Since life has prospered in nearly every possible niche on Earth, there is a good chance that the same would hold true with other planets in the universe. Dr. Penelope Boston, a microbiologist who studies life in extreme environment, says that, "when we look at our own planet's most challenging environments, we are really looking for clues to what may be the normal conditions on other planets. We want a hint of what we may be searching for when we investigate those other worlds for signs of life".

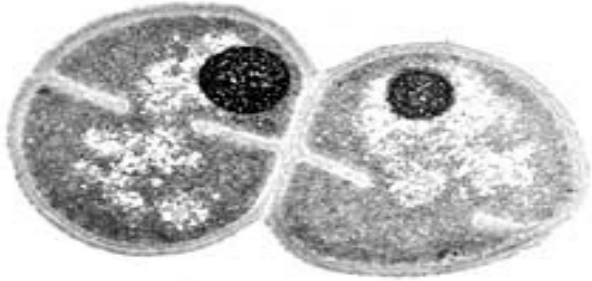
Certain environments on Earth mimic the features of other planets in our solar system. For example, the Antarctic Dry Valleys may represent the conditions on Mars and the oceans of Europa could support life forms similar to those which inhabit the hydrothermal vents in oceans on Earth. By studying the wide variety of eclectic life forms on Earth, scientists will be all the more prepared to recognize strange life forms on other planets.



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While the search for life in extreme environments on Earth is primarily fueled by curiosity and the desire for knowledge, the information gathered from researching life in these environments also has applications in industry.

For example, the bacteria pictured to the left (photo courtesy J. Battista) are able to withstand high doses of radiation. If scientists could identify the exact physiological and biochemical characteristics that permit these bacteria to survive in this hostile environment, they might be able to genetically modify other organisms to have the same abilities.



This is a picture of the famous hot springs in Yellowstone Park. Bacteria flourish in the boiling hot water. Courtesy: AltaVista Images